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A COMPUTER-ASSIST MATERIAL TRACKING SYSTEM AS A CRITICALITY SAFETY AID TO OPERATORS

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A COMPUTER-ASSIST MATERIAL TRACKING SYSTEM AS A CRITICALITY SAFETY AID TO OPERATORS

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Introduction

In today's compliant-driven environment, fissionable material handlers are inundated with work control rules and procedures in carrying out nuclear operations. Historically, human errors are one of the key contributors of various criticality accidents. Since moving and handling fissionable materials are key components of their job functions, any means that can be provided to assist operators in facilitating fissionable material moves will help improve operational efficiency and enhance criticality safety implementation.

From the criticality safety perspective, operational issues have been encountered in Lawrence Livermore National Laboratory (LLNL) plutonium operations. Those issues included lack of adequate historical record keeping for the fissionable material stored in containers, a need for a better way of accommodating operations in a research and development setting, and better means of helping material handlers in carrying out various criticality safety controls. Through the years, effective means were implemented including better work control process, standardized criticality control conditions (SCCC) and relocation of criticality safety engineers to the plutonium facility. Another important measure taken was to develop a computer data acquisition system for criticality safety assessment, which is the subject of this paper. The purpose of the Criticality Special Support System (CSSS) is to integrate many of the proven operational support protocols into a software system to assist operators with assessing compliance to procedures during the handling and movement of fissionable materials.

Many nuclear facilities utilize mass cards or a computer program to track fissionable material mass data in operations. Additional item specific data such as, the presence of moderators or close fitting reflectors, could be helpful to fissionable material handlers in assessing compliance to SCCC's. Computer-assist checking of a workstation material inventory against the designated SCCC to enhance the material movement was also recognized. The following three additional functions of the CSSS were requested by operational personnel: additional record keeping, assisting room inventory Material at Risk (MAR) calculations and generating the material label to be placed on a storage can.

In 1998, a preliminary CSSS concept was presented to all key stakeholders for the feasibility of such an application. Subsequently, the CSSS was developed with full participation of all stakeholders including fissionable material handlers. In 2003, five CSSS workstations were deployed in the plutonium facility for beta testing and resolving any issues from the field uses. Currently, the CSSS is deployed in all laboratories in the LLNL Plutonium Facility. Initial deployment consists of only a few of the full system functions described in this paper. Final deployment of all functions will take a few more years to assure the system meets quality assurance requirements of a safety significant system.

1. Development History

Lawrence Livermore National Laboratory conducts a variety of research and development activities with significant amounts of un-encapsulated fissile material as part of its national security mission. Compliance with government regulations, national standards, and laboratory policies mandate the need to maintain an acceptable margin of criticality safety in these activities. Operating personnel involved in the handling of the fissile material must determine whether an operation can be conducted safely within the evaluated SCCC limits and work control process.

With the advance of personal computer technology, it has become practical for LLNL to provide operators with a more user-friendly tool to assist them in carrying out criticality safety assesments. Relatively inexpensive database applications provided the ability to populate, modify, and update a database with the information necessary to assist operators in compliance with specific SCCC limits prior to a fissionable material move. User-friendly graphical interfaces can be used for the entry and display of applicable information. Data input can be acquired by using pre-configured menus and automatic entries from barcode scanners, digital cameras, or other instrumentation with an interface to a personal computer. The availability of high-speed networks and data storage devices also provides an opportunity for distributed applications and shared file access.

2. CSSS Description

The system consists primarily of three interdependent computer programs that include: the creation of CSSS labels; the assessment of fissile material movements; and the modification of the SCCC rules set.

When a CSSS label is required for a package, a material handler accesses the Controlled Material Accountability Tracking System (COMATS) to input or retrieve mass data (Figure 1). The CSSS label program then accesses the same data that may then be included with other criticality information provided by the handler such as form, shape, contaminates etc. These procedures require verification from a second handler before an adhesive label is created. The cumulative data may be augmented with digital camera images of the package and is then maintained in the CSSS database for subsequent retrieval using a barcode scan of the package label part number.

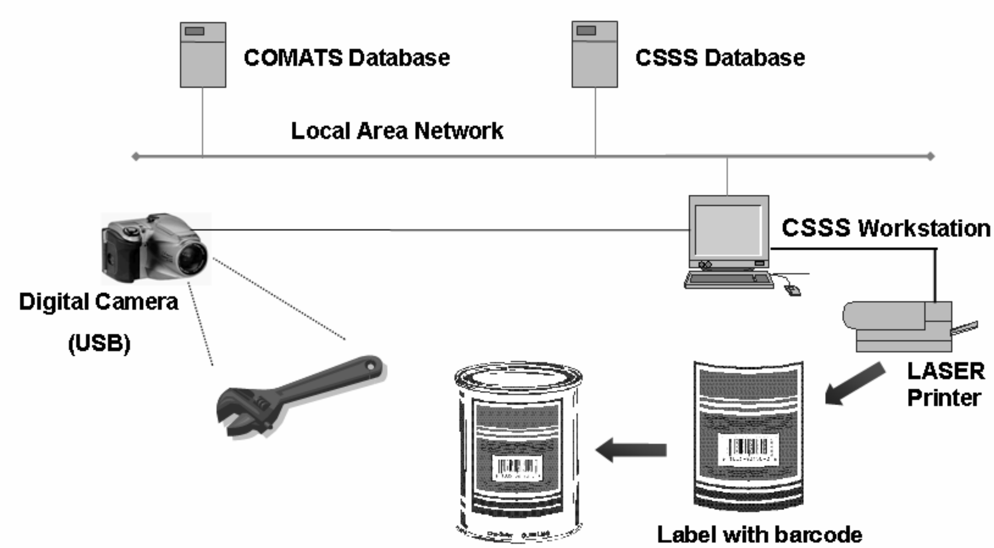

Figure 1. CSSS data input and CSSS label creation

When the movement of fissile material within the Plutonium Facility is required, the CSSS can provide assistance to the material handlers to determine the appropriateness of the move (Figure 2). If the material mass tracking system permits the move, the handler then accesses the CSSS to determine if the item is acceptable to the target workstation under the prevailing criticality limits and special conditions in force for the workstation. Interfacing with COMATS, the CSSS will monitor the status of fissionable material movement on a real time basis. Upon a handler’s request of an intended operation, it will provide specific workstation criticality advisory, such as; verify that that item meets the basics of the SCCC that currently applies to the workstation. During workstation operations, the handler can input the new part data formed in the workstation and can use a digital camera to record the item before placing it into an appropriate storage container. The CSSS will then print a unique bar code and other data on an adhesive label to be placed onto the can. The CSSS will have additional on-line capabilities of displaying, per handler request, the authorized work control document procedure to assist handlers, and can acquire the fissionable material handler's requests of material moves for future job training use. One of the key features of the CSSS is the capability to provide various menus on the monitor screen to assist handlers in entering fissionable material data such as form, shape, packaging, and material data. It also performs various calculation tasks to assist tracking of the room inventory limit.

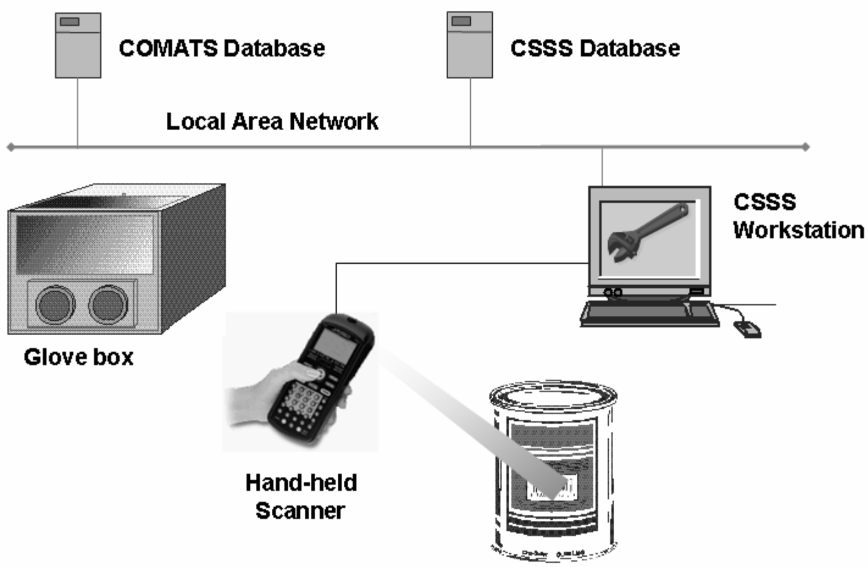

Figure 2. CSSS data retrieval and workstation criticality assessment

An additional program is used to update the content of the selection menus, to add or modify specific limits, constraints, and special items allowed for a given glove-box, and to maintain the SCCC attributes used by the criticality assessment program. The development of the CSSS involved the participation of all main stakeholders including facility management, program leaders, material accountability, fissionable material handlers, and criticality safety. Many discussions were held to explain the CSSS and its uses and to solicit comments from the stakeholders.

3. CSSS Deployment Status

During the CSSS implementation phase, many minor problems encountered in the field applications were fixed. A Plutonium Facility Operational Readiness Review was conducted to capture and document required corrections or improvements for subsequent software releases. Since the pilot system deployment in October 2003, nearly nine hundred parts have been identified, labeled, and stored in the CSSS database. Twenty-four systems were deployed for production use in October 2006, and have been used to collect data and label an additional two hundred thirty parts. When software quality assurance is completed on the criticality assessment capability and the CSSS database becomes more fully populated with inventory data the assessment function will be actively used to provide handlers with an important operational aid.

Conclusions

Nuclear facility operations rely on many organizational elements in carrying out their respective functions. Any proposed changes such as CSSS to an existing operational setting will necessitate adjustments of many stakeholders in carrying out their operations. As such, it is prudent to involve all stakeholders in the planning phase of any such innovation. The Criticality Special Support System provides user-friendly assistance to fissile material handlers in assessing compliance with criticality safety controls. Inclusion of data on moderators and close-fitting reflectors, in addition to fissionable material mass data, has assured that these attributes of a given item are readily available to operators in implementing criticality safety limits. The data recording capability of material contents in storage containers will practically avoid the legacy fissionable material storage issue where the information of the stored item was lost years ago due to various reasons. The use of a bar code system will also ease the retrieval of and tracking of fissionable material in a convenient way to facilitate nuclear operations.

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